Embryonic development

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Stages of early embryogenesis

Zygote (single-cell stage)

⬇

Cleavage (mitotic division)

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Morula (compact multicellular stage)

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Blastula (first embryonic cavity - blastocoel)

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Gastrulation (germ layers formation)

⬇

Gastrula (germ layers, blastopore, a new cavity - gastrocoel or archenteron – primary intestine)

⬇

Organogenesis

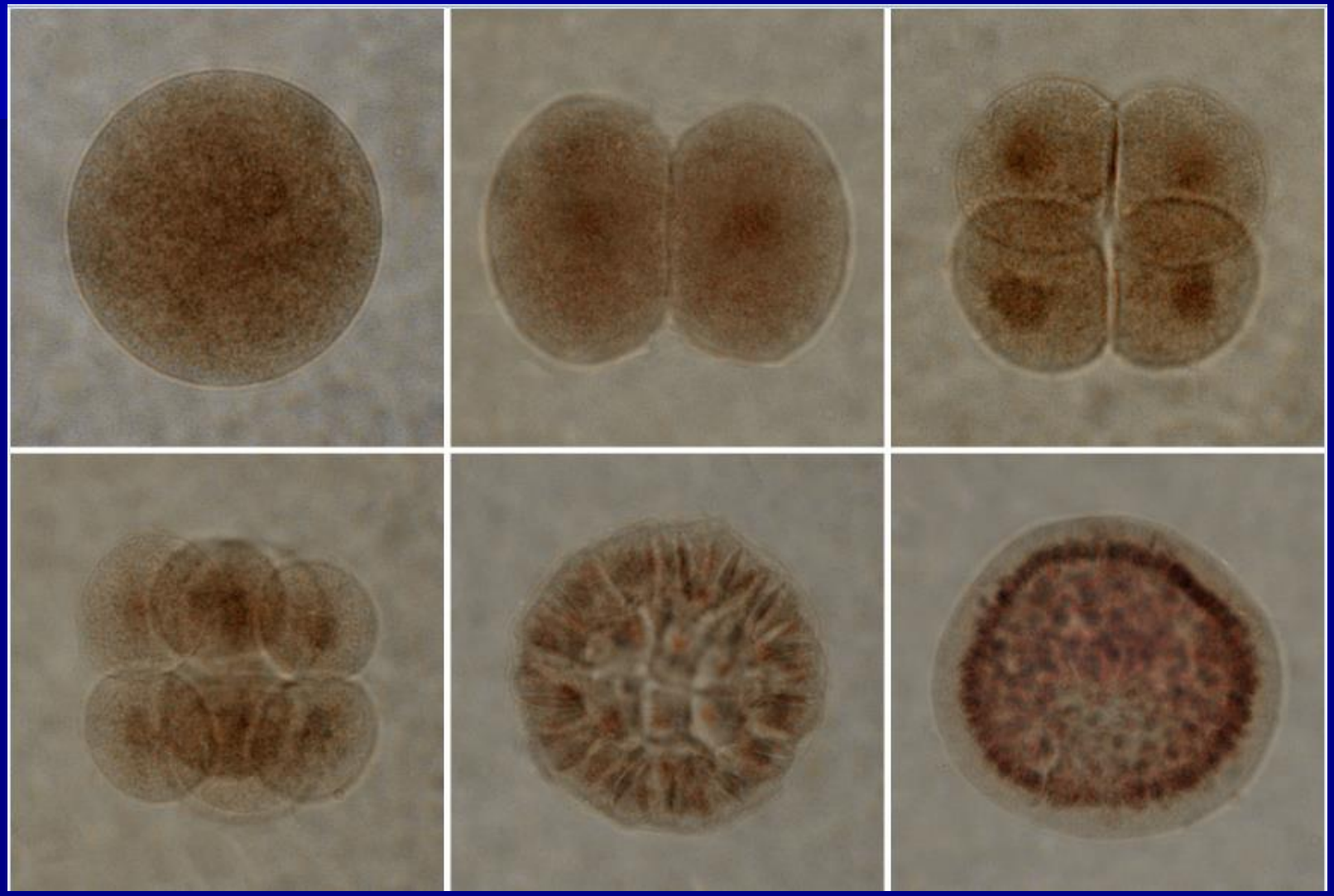
Development begins with cleavage

Cleavage is the first stage of embryonic development. It includes consecutive mitotic divisions which produce multicellular organism from the unicellular zygote. Mitosis during cleavage are very fast with brief interphases. In these interphases have no growing of the cell mass. That's why these consecutive divisions produce smaller and smaller cells, which number increase in geometric progression – 2, 4, 8, 16 etc.

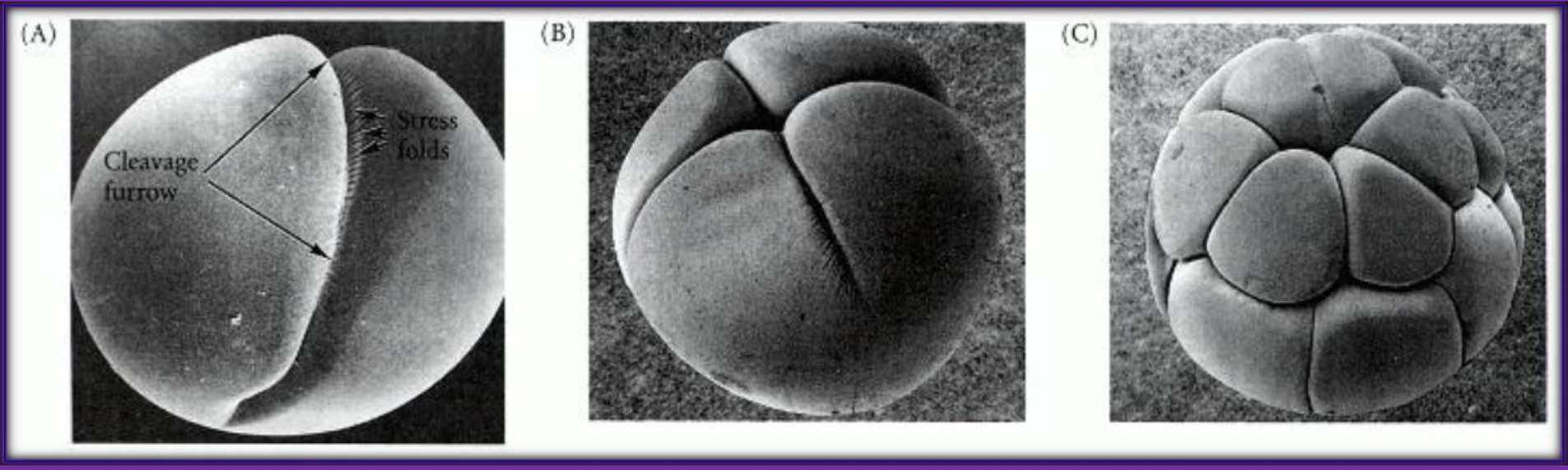
Sea urchin zygote and early embryos

www.exploratorium.edu

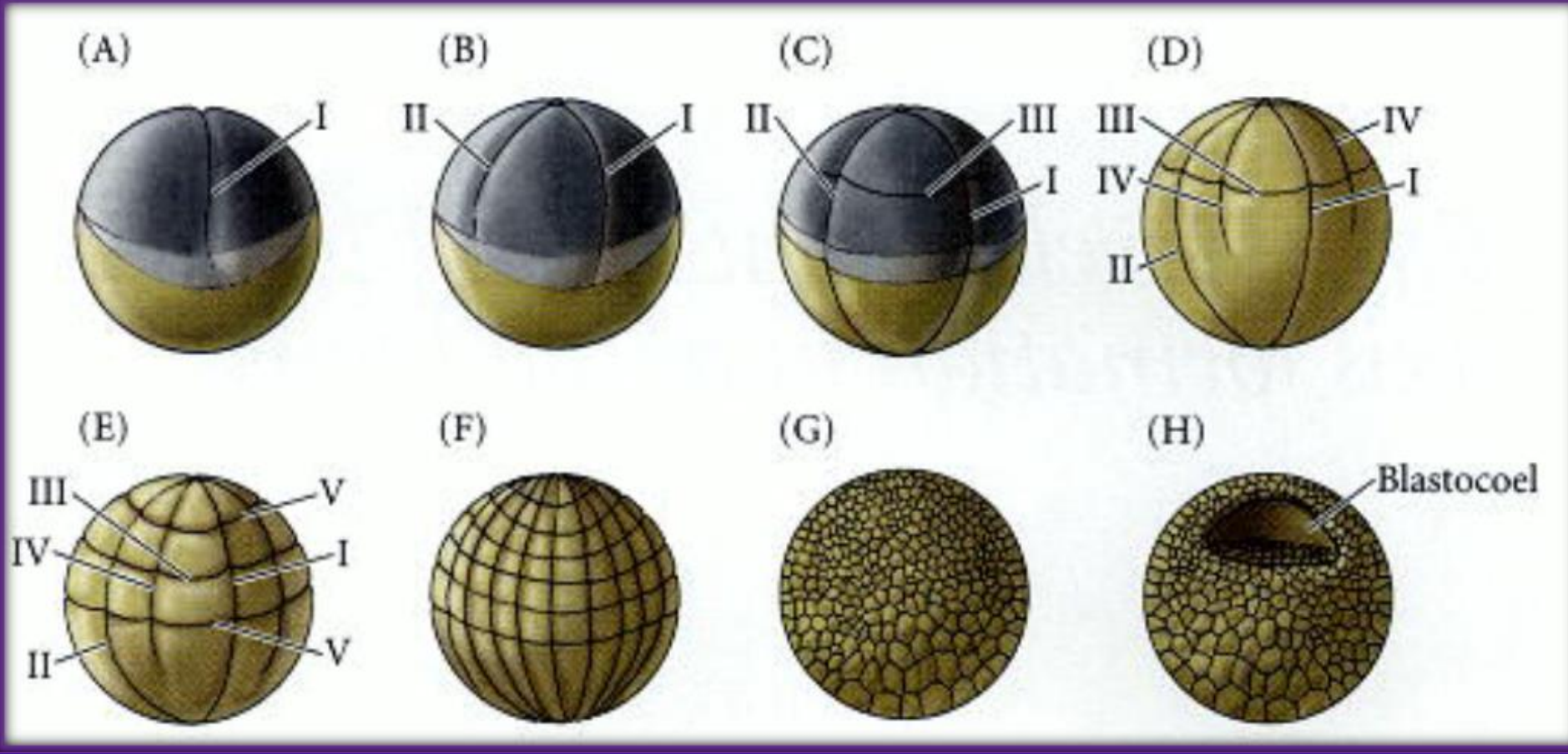
Cleavage in sea urchins



Early frog embryos



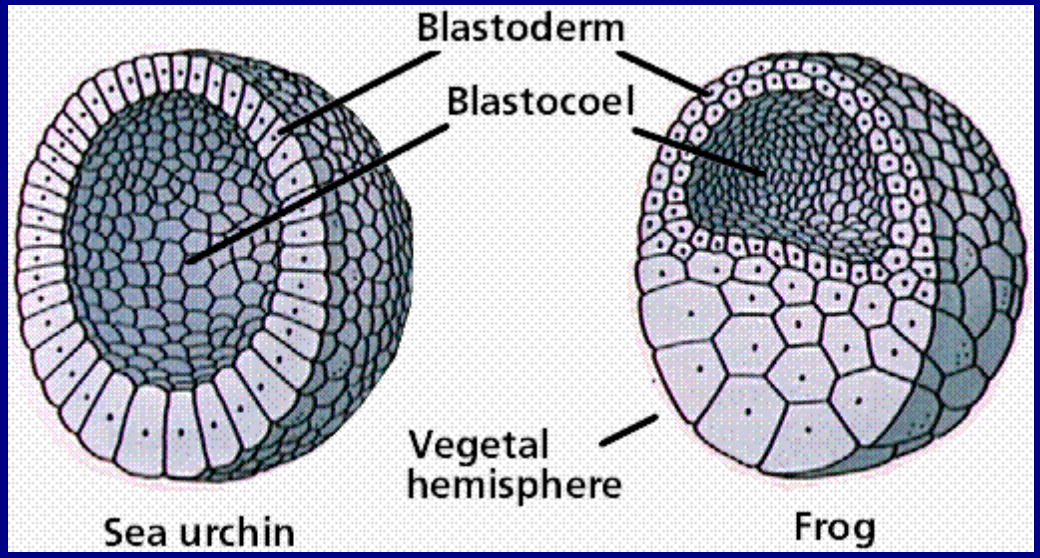
Cleavage in amphibians



Blastula - an animal embryo at the early stage of development, usually a hollow ball of cells

When cleavage progresses, the embryo looks like a blackberry – a ball with a lot of small cells. This stage is named morula.

During next stage – blastula, the first embryonic cavity is formed. In one moment the cells in the periphery of the sphere contact closely with each other. In this way, these cells isolate the center of the sphere where a cavity is formed. By ionic transport water is pumped in the cavity. This hallow becomes blastocoel. The blastocoel has a crucial role during next stage – gastrulation. Germ layers formation require cell migration. This cavity, filled with liquid, provides an environment for these migrations. Blastocoel isolates different cell populations which have to avoid contacts in order to differentiate correctly.



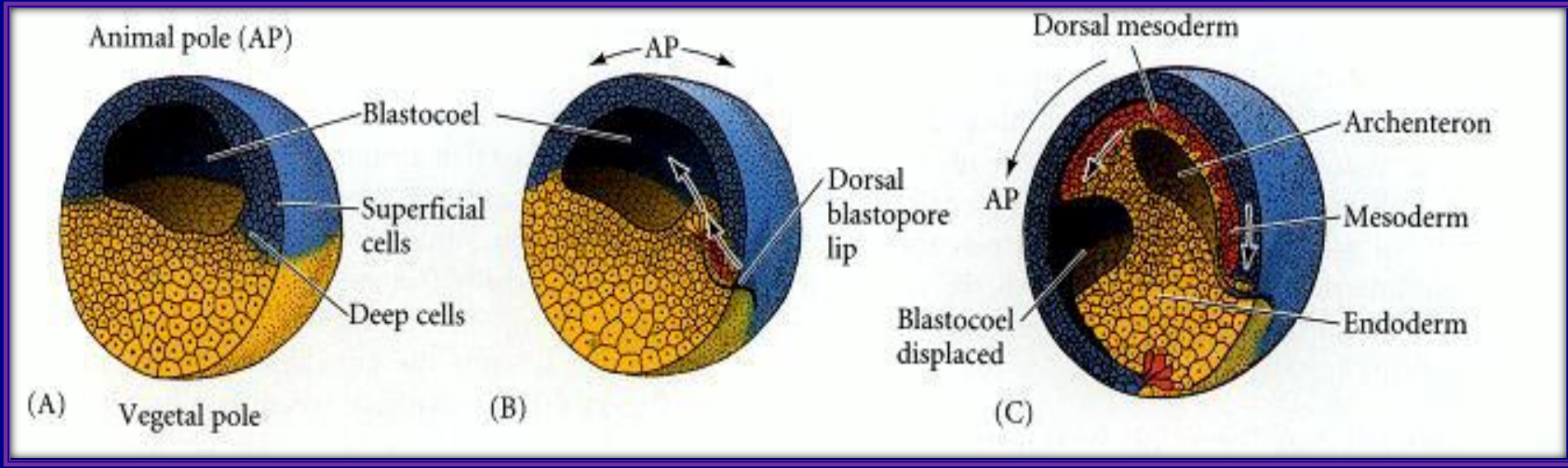
Purves et al., Life: The Science of Biology, 4th Edition, by Sinauer Associates

Gastrulation

Gastrulation is the stage in which three germ layers (ectoderm, endoderm and mesoderm) are formed. It starts by invagination – group of cells bend inward. This first opening becomes the anus of the embryo later. These bended cells multiply and migrate deeper to form the innermost embryonic layer – endoderm. The outer layer of cells form the ectoderm. The cells between these layers produce mesoderm.

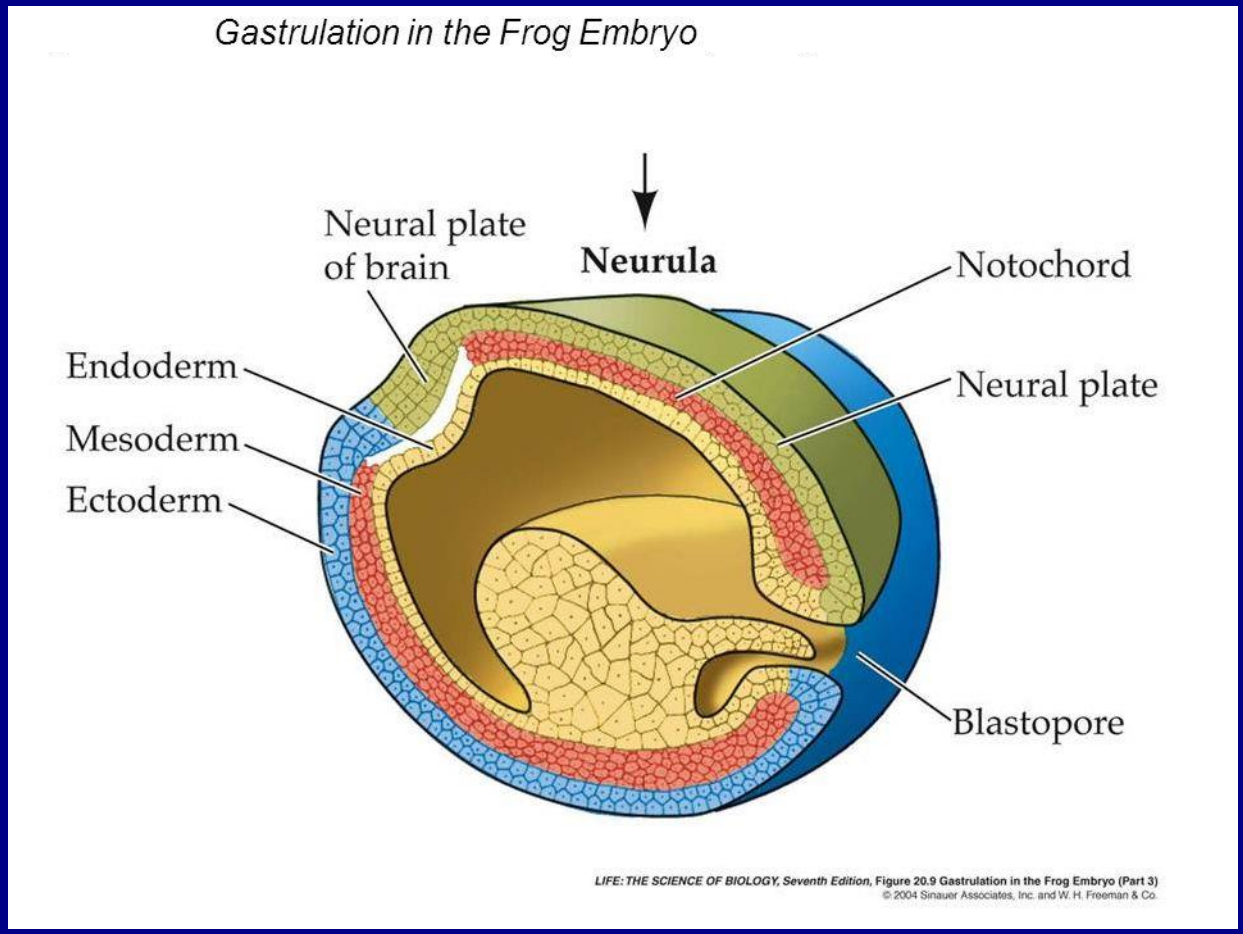
Gastrulation in sea urchins

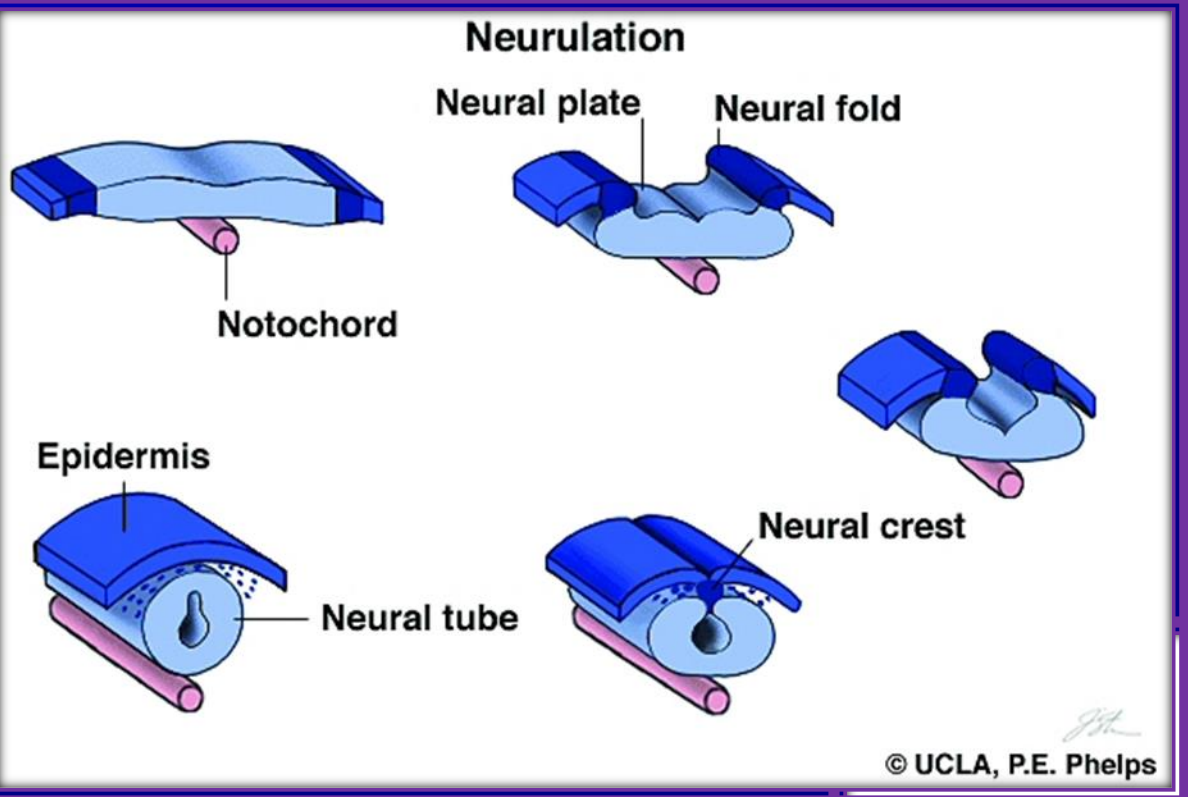
Gastrulation in amphibians



Gastrula - an embryo at the stage following the blastula, when it is a hollow cup-shaped structure having three layers of cells.

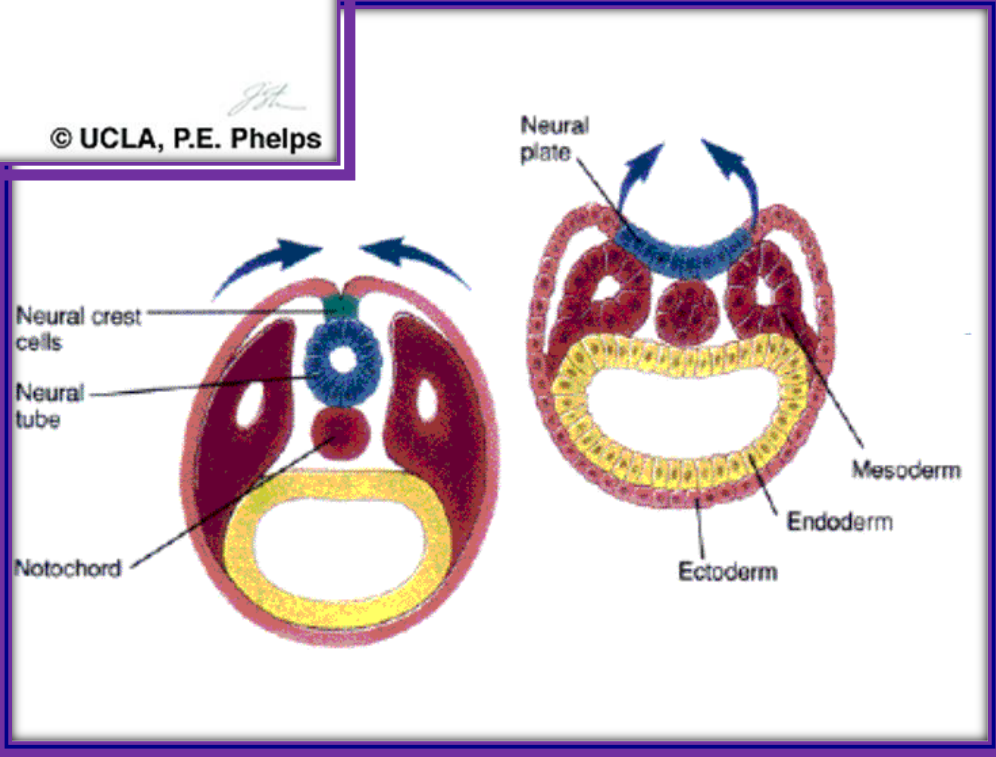
Toward the end of gastrulation, the blastocoel is obliterated, the embryo is surrounded by ectoderm, the endoderm is internalized, and the mesoderm is between the ectoderm and endoderm.





Nervous system is formed from ectoderm

The cells of the dorsal ectoderm elongate and multiply to form a neural plate. It folds inward to form neural groove. The ends of neural groove fuse to produce neural tube. The front part of the neural tube forms the brain and the back part – spinal cord.



Germ layers and their derivatives

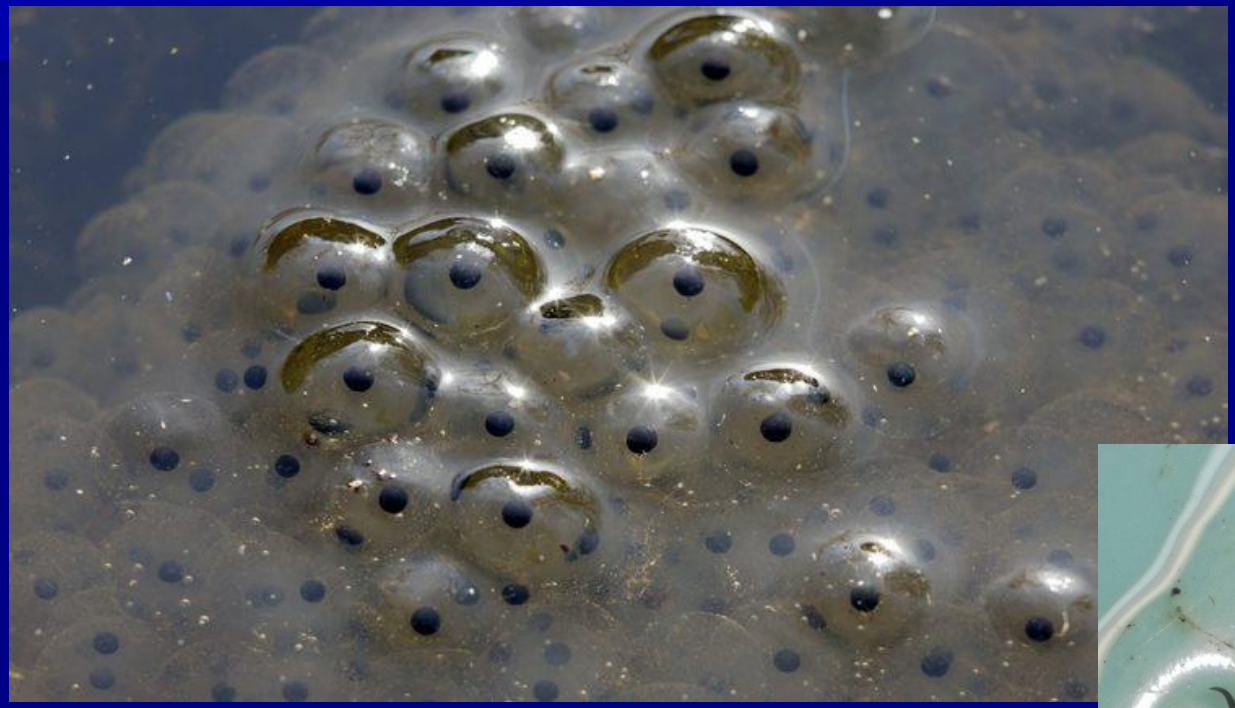
From ectoderm: neural tissue
epidermis of the skin and its derivates – sweat glands, nails, hairs.

From mesoderm: bones
muscles
blood.

From endoderm: digestive tract and its accessory organs – liver, gall bladder and pancreas.

Embryonic development of amphibians takes place in water

https://animals.mom.me/how-to-hatch-frog-eggs-6066099.html



https://poisondartfrogbreeding.weebly.com/articles/egg-and-tadpole-care

Embryonic development of mammals takes place in the mother's body

In placental mammals, mother and fetus are connected by placenta

The placenta is a temporary organ that connects the developing fetus to the uterine wall and allow nutrient uptake, thermo-regulation, waste elimination, and gas exchange via the mother's blood circulation.